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$$A=P(1+\frac{r}{q})^{nq}\ldots\ldots(1).$$

Expanding the right hand member in (1) by the binomial theorem, we have

$$A=P(1+nq.\frac{r}{q}+\frac{nq(nq-1)}{2\,!}.\frac{n^2}{q^2}+\ldots\ldots(2).$$

When $q=\infty$, equation (2) becomes

$$A=P(1+nr+\frac{n^2r^2}{2\,!}+\frac{n^3r^3}{3\,!}+\text{etc.,})=,$$

by the exponential theorem, $Pe^{nr}\ldots\ldots(3)$.

Whence by taking logarithms in (3) and changing to the common system by multiplying by its modulus we have in inverse functions

$$A=P\log(1.4342944nr)=106.1836,$$

when $n=1$, $r=.06$, and $P=100$.

Having determined the rate in equivalent annual compound rate, the required annual payment is determined as follows :

$1\div1.061836=.941765=P$

$1\div1.061836^2=.886913=P'$

$1\div1.061836^3=.8352716=P''$

$1\div1.061836^4=.7866294=P'''$.

Now $\$6000\div(P+P'+P''+P''')=\$1738.834$.

This problem was also solved by *B. F. YANNEY.*

ALGEBRA.

Conducted by **J. M. COLAW**, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

50. Proposed by **LEONARD E. DICKSON, M. A.**, Fellow in Mathematics, University of Chicago.

Given $b=a\sqrt{-1}.\tan\frac{m\pi}{n}$, m being an arbitrary integer, find the simplest *algebraic* relation between a and b.

Solution by the PROPOSER.

From $b=ai\tan\frac{m\pi}{n}$, where $i=\sqrt{-1}$, we derive $\frac{a+b}{a-b}=\frac{1+i\tan\frac{m\pi}{n}}{1-i\tan\frac{m\pi}{n}}$

$$=\frac{1-\tan^2\frac{m\pi}{n}+2i\tan\frac{m\pi}{n}}{1+\tan^2\frac{m\pi}{n}}=\cos^2\frac{m\pi}{n}-\sin^2\frac{m\pi}{n}+2i\sin\frac{m\pi}{n}.\cos\frac{m\pi}{n}=\cos\frac{2m\pi}{n}$$

$+i\sin\frac{2m\pi}{n}$, the n^{th} power of which, by De Moivre's Theorem, equals 1.

$\therefore\ (a+b)^n=(a-b)^n$.

Also solved by *F. P. MATZ.*

51. **Proposed by J. W. NICHOLSON, LL. D., President, and Professor of Mathematics, Louisiana State University and A. and M. College, Baton Rouge, Louisiana.**

Solve the equation $x^5+5mx^3+5m^2x+n=0$.

I. Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Applied Science, Texarkana College, Texarkana, Arkansas-Texas.

Let $x=y+z$. The equation then easily reduces to $y^5+z^5+5(yz+m)\{y^3+z^3+(2yz+m)(y+z)\}+n=0$. Now x may be decomposed into two parts, y and z, in an infinite variety of ways, and we may, therefore, suppose y and z are such as to satisfy the condition $yz+m=0$. This gives $yz=-m$, $y^5+z^5=-n$. Let $y^5=t_1$, $z^5=t_2$, then we have $t_1t_2=-m^5$, $t_1+t_1=-n$. $\therefore$ t_1 and t_2 are the roots of the equation $t^2+nt-m^5=0$......(1). $\therefore\ x=y+z=\sqrt[5]{t_1}+\sqrt[5]{t_2}$.

Case I. When m is positive.

Let $t=u\sqrt{m^5}$, then (1) becomes $u^2+\frac{n}{\sqrt{m^5}}u-1=0$; but $\tan^2\frac{1}{2}\theta+2\cot\theta\tan\frac{1}{2}\theta-1=0$. $\therefore\ 2\cot\theta=n/\sqrt{m^5}$, or $\tan\theta=2\sqrt{m^5}/n$. $\therefore\ t_1=\sqrt{m^5}\tan\frac{1}{2}\theta$, $t_2=-\sqrt{m^5}\cot\frac{1}{2}\theta$. $\therefore\ x=\sqrt{m}(\sqrt[5]{\tan\frac{1}{2}\theta}-\sqrt[5]{\cot\frac{1}{2}\theta})$, where $\theta<90°$. Four of the five roots of $\sqrt[5]{\tan\frac{1}{2}\theta}$ are imaginary. Let $\tan\frac{1}{2}\phi=r$=the real value of $\sqrt[5]{\tan\frac{1}{2}\theta}$, and let a_1, a_2, a_3, a_4 represent the four imaginary roots of unity

$$\frac{\sqrt{5}-1+\sqrt{-10-2\sqrt{5}}}{4},\quad \frac{\sqrt{5}-1-\sqrt{-10-2\sqrt{5}}}{4},\quad \frac{-\sqrt{5}-1-\sqrt{-10+2\sqrt{5}}}{4},$$

$\frac{-\sqrt{5}-1+\sqrt{-10+2\sqrt{5}}}{4}$, respectively.

Then $x_1=\sqrt{m}(r-\frac{1}{r})$, $x_2=\sqrt{m}(ra_1-\frac{1}{ra_1})$, $x_3=\sqrt{m}(ra_2-\frac{1}{ra_2})$, $x_4=\sqrt{m}(ra_3=\frac{1}{ra_3})$, $x_5=\sqrt{m}(ra_4-\frac{1}{ra_4})$. Substituting the values of r, a_1, a_2, a_3, a_4,